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FOREST SERVICE

PROGRESS REPORT

PREDATOR INTRODUCTIONS IN 1959 FOR CONTROL OF THE BALSAM WOOLLY APHID AND AN EVALUATION OF RELEASES TO DATE

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TABLE OF CONTENTS

	Page
SUMMARY	1
INTRODUCTION	2
PREDATOR INTRODUCTION PROGRAM IN 1959	3
Aphidoletes thompsoni	4
Collection and shipment	4
Laboratory rearing	5
Field liberation	6
Laboratory propagation	6
Laricobius erichsonii	7
Aphidecta obliterata	7
Cremifania nigrocellulata	7
Leucopis (Neoleucopis) sp.	8
Neoleucopis obscura	8
Scymnus (Diomus) pumilio	8
Miscellaneous Coccinellidae	8
Exochomus uropygialus	8
Synharmonia conglobata	8
Adalia tetraspilota var. *bispilota*	9
Ballia eucharis	9
Leis dimidiata	9
Harmonia breiti	9
ESTABLISHMENT AND EFFECTIVENESS OF PREDATORS INTRODUCED SINCE 1957	9
Aphidoletes thompsoni	10
Laricobius erichsonii	10
General observations	10
Special field study in 1959	10
Aphidecta obliterata	13
Chilocorus kuwanae	15
Cremifania nigrocellulata	15
Leucopis (Neoleucopis) sp.	15
Neoleucopis obscura	15
Scymnus (Diomus) pumilio	15
Miscellaneous Coccinellidae	16
PROJECT PERSONNEL	16
APPENDIX	17

LIST OF TABLES AND ILLUSTRATIONS

Tables — Page

1. Summary of foreign predators released in Oregon and Washington in 1959 for control of the balsam woolly aphid 4

2. Summary of rearing data of Aphidoletes thompsoni in 1959 . . . 5

3. Summary of rearing data of Aphidoletes thompsoni from 1957 through 1959 5

4. Summary of foreign predators released in Oregon and Washington from 1957 through 1959 9

5. Shipments and colonizations of foreign predators of the balsam woolly aphid in 1959 18

6. Summary of 1959 rearings of Aphidoletes thompsoni -- shipment No. 1 21

7. Summary of 1959 rearings of Aphidoletes thompsoni -- shipment No. 2 23

8. Summary of 1959 rearings of Aphidoletes thompsoni -- shipment No. 3 25

9. Summary of proctotrupid parasite emergence from Aphidoletes rearings of shipments 1, 2, and 3 -- Sellwood Laboratory, 1959 27

10. Summary of foreign predator releases and observations from 1957 through 1959 28

Figures Page

1. Walk-in study cage in grand fir woodlot at Monroe, Oregon 11

2. Rating effectiveness of foreign predators with a microscope mounted on camera tripod 12

3. 1959 population trend of Chermes adults on sample plots protected or not protected from predation by Laricobius erichsonii. (Study tree at Monroe, Oregon). (Graph) 14

4. Emergence of Aphidoletes thompsoni adults from shipment No. 1 -- Sellwood Laboratory, 1959. (Graph) . . . 22

5. Emergence of Aphidoletes thompsoni adults from shipment No. 2 -- Sellwood Laboratory, 1959. (Graph) . . . 24

6. Emergence of Aphidoletes thompsoni adults from shipment No. 3 -- Sellwood Laboratory, 1959. (Graph) . . . 26

7. Release points of foreign predators of the balsam woolly aphid in Oregon and Washington 1957 through 1959. (Map) 31

SUMMARY

The program which was started in 1957 to introduce foreign insect predators of the balsam woolly aphid was continued and expanded in 1959. During the year, 13 species of predators totaling 38,445 specimens were released in various locations in western Oregon and Washington. Since 1957, a total of 53,220 predators representing 14 species have been released.

Twelve of the species released in 1959 were provided by the Canadian Department of Agriculture, and the other by the Northeastern Forest Experiment Station of the U. S. Forest Service. Arrangements to obtain predators were made by the Washington, D. C., Office of the Forest Service and the Agricultural Research Service, U. S. Department of Agriculture. The predators released in 1959 are listed in the following table.

Species	Source	No. released
Aphidoletes thompsoni (Diptera: Itonididae)	Czechoslovakia and Germany	29,894
Neoleucopis obscura (Diptera: Chamaemyiidae)	Maine	2,085
Exochomus uropygialus (Coleoptera: Coccinellidae)	Pakistan	1,957
Laricobius erichsonii (Coleoptera: Derodontidae)	Germany	1,600
Cremifania nigrocellulata (Diptera: Chamaemyiidae)	Germany	989
Scymnus (Diomus) pumilio (Coleoptera: Coccinellidae)	Australia	859
Aphidecta obliterata (Coleoptera: Coccinellidae)	Germany	718
Synharmonia conglobata (Coleoptera: Coccinellidae)	India	121
Adalia tetraspilota (Coleoptera: Coccinellidae)	India	89
Ballia eucharis (Coleoptera: Coccinellidae)	Pakistan	85
Leis dimidiata (Coleoptera: Coccinellidae)	India	23
Leucopis (Neoleucopis) n. sp. (Diptera: Chamaemyiidae)	Pakistan	15
Harmonia brieti (Coleoptera: Coccinellidae)	India	10
	Total	38,445

The Aphidoletes thompsoni specimens were received as larvae, pre-pupae, and pupae, and the Leucopis (Neoleucopis) n. sp. as pupae. All other species arrived as adults. Shipments of A. thompsoni were reared to the adult stage at Sellwood Laboratory in Portland. The shipment of Leucopis was reared at the Oregon State College Forest Insect Laboratory in Corvallis.

The predators received in 1959 were released at three different areas in Washington, and nine in Oregon. Both free and cage methods were used when making releases.

By the fall of 1959, Aphidoletes thompsoni, Laricobius erichsonii, Neoleucopis obscura, and Cremifania nigrocellulata were at least temporarily established as a result of the 1959 releases. A. thompsoni and L. erichsonii have overwintered successfully as a result of the 1957 or 1958 introductions.

On release trees with heavy bole infestations, L. erichsonii, Aphidecta obliterata, and Aphidoletes thompsoni has reduced chermes populations noticeably. A special field study on Laricobius erichsonii quantitatively assessed a segment of the reduction.

A rearing experiment showed that Aphidoletes thompsoni could be propagated in the laboratory on chermes-infested logs.

Helpful assistance was provided by entomologists of Weyerhaeuser Company and Oregon State College in selecting release sites, releasing predators, and evaluating establishment.

INTRODUCTION

1959 marked the third year of a program to introduce insect predators of the balsam woolly aphid (Chermes piceae Ratz.) 1/ 2/ The program was begun in 1957 when damage by the aphid covered some 600,000 acres in Oregon and Washington. The first year, 1830 predators of only one species, Aphidoletes thompsoni, were released; in 1958, almost 13,000 predators representing 6 species were liberated. In 1959, the program was further expanded with the importation and release of 38,445 specimens from 13 species. The following report describes the work connected with importation, rearing and release of the predators in 1959. It also discusses the status of all species released since 1957 and general observations on the effectiveness of several species.

1/ Wright, K. H. and R. G. Mitchell. Progress Report: Colonization in Oregon and Washington of Aphidoletes thompsoni - An European Predator of the Balsam Woolly Aphid. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon, Feb. 1, 1958.

2/ Wright, K. H., P. E. Buffam, and R. G. Mitchell. Progress Report: Colonization of Foreign Insect Predators in 1958 for Control of the Balsam Woolly Aphid. Pacific Northwest Forest and Range Experiment Station. Portland, Oregon, March 15, 1959.

Predators were supplied by the Canadian Department of Agriculture, Research Branch, from collections made by the Commonwealth Institute of Biological Control, and by the Northeastern Forest Experiment Station, U. S. Forest Service. The research branch of the U. S. Forest Service and the Entomology Research Division of the U. S. Agricultural Research Service made the arrangements with Canada. Dr. B. P. Beirne, Officer-in-Charge of the Entomology Research Institute of Biological Control at Belleville, Ontario, represented Canada in the cooperative agreements. Dr. J. A. Rudinsky of Oregon State College and N. E. Johnson of Weyerhaeuser Company Forestry Research Center at Centralia, Washington, assisted in the handling and release of some predators.

PREDATOR INTRODUCTION PROGRAM IN 1959

Thirteen species of foreign predators were received and released in the Pacific Northwest in 1959. Twelve species were provided by the Canadian government and one by the Northeastern Forest Experiment Station. Insects sent by the Canadians were field collected in Europe, Pakistan, India, and Australia by the Commonwealth Institute of Biological Control. The one species received from the Northeastern Station was collected by Forest Service entomologists in Maine.

The first of 22 predator shipments arrived in Portland on May 1 and the last on Oct. 12. All shipments were examined at the Sellwood laboratory before they were taken to the field for release. Five species were released in Washington and eleven in Oregon. Table 1, which follows, lists the species introduced in 1959, their sources, the number released, and whether they were released in Oregon or Washington. Table 5 in the Appendix provides a more complete summary of the number of each species received, when they arrived, names of release points, and other details.

Population level of the balsam woolly aphid was high during 1959, and adequate bole-infested trees were generally available for release purposes. The first release was made May 2, and the last October 13.

Release methods of the two previous years were used again in 1959; techniques and materials have been reported.3/ 4/ With some species, all the specimens received were released free, while others were released entirely in cages. The shipments of some species were split, and both methods used. An advantage of the cage release was that it prevented rapid dispersal, and thus provided greater opportunity for mating. This was especially important in those cases where the species were very active, or when a limited number of specimens was available for release. When winds were strong and the predator species was small and fragile (such as Aphidoletes thompsoni) cage releases were found desirable even though a large number of insects were available. For those species that pupated in the soil, it was necessary to remove the cage fairly soon after release. This was somewhat of a problem in remote areas.

3/ 4/ See footnotes 1 and 2, page 2.

Table 1.--Summary of foreign predators released in Oregon and Washington in 1959 for control of the balsam woolly aphid

Species	Source	No.adults released in Wn. in 1959	No.adults released in Ore.in 1959
Adalia tetraspilota Hope var. bispilota Wse.	India		89
Aphidecta obliterata L.	Germany	718	
Aphidoletes thompsoni Möhn	Czechoslovakia and Germany	5,385	24,509
Ballia eucharis Muls.	Pakistan		85
Cremifania nigrocellulata Cz.	Germany		989
Exochomus uropygialus Muls.	Pakistan	1,641	316
Harmonia breiti Mader	India		10
Laricobius erichsonii Rosenh.	Germany		1,600
Leis dimidiata F.	India		23
Leucopis (Neoleucopis) n. sp.	Pakistan		15
Neoleucopis obscura (Hal.)	Maine		2,085
Scymnus (Diomus) pumilio (Wse.)	Australia	859	
Synharmonia conglobata L.	India	91	30
	Total	8,694	29,751
	Grand total	38,445	

Following are details of the collection, shipment, and liberation of the 13 species of foreign predators received in 1959.

Aphidoletes thompsoni Möhn (Diptera: Itonididae)

Collection and shipment - Three shipments of Aphidoletes thompsoni totaling 117,000 larvae, pre-pupae, and pupae were received in 1959 (see table 5 in Appendix). The first shipment was collected in Czechoslovakia in the fall of 1958 and sent to the Entomology Research Institute of Biological Control at Belleville, Ontario. There it was stored overwinter in moist vermiculite under refrigeration. The second and third shipments were collected during the spring of 1959 in Germany and sent to Belleville for processing and shipment to other Canadian Laboratories, and to Portland. Shipments from Belleville travelled by rail to Toronto and then by Air Express to Portland.

The shipping container used to transport Aphidoletes to Portland this year was different from the ones used in 1957 and 1958. The outside container was an ordinary corrugated paper box lined with three layers of one-inch fiberglass insulation. The insects were placed in sand or vermiculite in small wooden boxes covered with a very fine mesh copper screen. The wooden boxes were padded with paper excelsior and covered with two layers of the fiberglass insulation. Cans of a chemical ice (Trade name: "Ice-Pak") were placed between layers of the insulation keeping the Aphidoletes very cool. All shipments arrived in good condition and were taken directly from the Portland Air Express Office to the Sellwood laboratory for rearing.

Laboratory rearing - Upon arrival at the Sellwood laboratory, the Aphidoletes larvae, pre-pupae, and pupae were examined and placed in rearing containers. The rearing materials and procedures used in 1959 were the same as reported previously.5/ Table 2 summarizes the rearing results for all three shipments of Aphidoletes received in 1959. (See tables 6, 7, 8 in the Appendix for additional details).

Table 2.--Summary of rearing data of Aphidoletes thompsoni in 1959

Shipment number	Number predators rec'd.: Larvae and prepupae	Number adults reared* : Males	Females	Total	Rearing success	Sex ratio	Parasitism
					Percent		Percent
1	30,000	273	918	1,191	4.0	1:3.36	0.1
2	56,000	8,063	13,388	21,451	38.3	1:1.66	2.6
3	31,000	2,811	4,535	7,346	23.7	1:1.61	0.2
Totals	117,000	11,147	18,841	29,988	25.6	1:1.69	1.3

* Includes adults that died in emergence vials.

To compare rearing success for Aphidoletes in 1959 with those of the two previous years, the results from all three years have been summarized as shown in table 3, which follows.

Table 3.--Summary of rearing data of Aphidoletes thompsoni from 1957 through 1959

Year	Number predators received	Number adults reared: Males	Females	Total	Rearing success	Sex ratio	Parasitism
					Percent		Percent
1957	10,000	737	1,380	2,117	21.2	1:1.9	2.4
1958	10,000	1,154	1,416	2,570	25.7	1:1.2	2.0
1959	117,000	11,147	18,841	29,988	25.6	1:1.7	1.3
Totals	137,000	13,038	21,637	34,675	25.3	1:1.7	1.5

5/ See footnote 2, page 2.

In 1959, rearing success was 0.1 percent less, sex ratio of females over males 0.5 greater, and parasitism 0.7 percent less than in 1958. One species of parasite was present -- the same small, black proctotrupid (probably Aphanogmus nigrofornicatus Schick) that emerged the two previous years (See table 9 in Appendix for parasite emergence data).

Because poor emergence occurred from the first shipment after 18 days of rearing, it was placed under refrigeration at 28° F. for a period of 18 days. It was reasoned that perhaps the storage temperature at Belleville had been too warm, and that the Aphidoletes should be subjected to cold temperatures similar to that experienced in nature. However, no emergence occurred after the cold-treatment. It appears that the sudden change from laboratory temperature to sub-freezing temperature killed the insects, which were already weakened by an unfavorable winter environment.

Mating of Aphidoletes was observed in the 4-inch emergence vials this year for the first time. The observation is added evidence that this predator doesn't necessarily need a large space in which to make mating flights, as has been suggested. In the field, colonization has been about equally successful with cage and free releases.

Following emergence, the adult predators were accumulated in excelsior-filled storage boxes and held at about 40° F. until time for release.

Field liberation - In 1959, a total of 29,894 Aphidoletes adults were released in Oregon and Washington. Predators were transported in iced chests by automobile from the Sellwood laboratory to field release points. Temperatures in the chests were about 50°, and the predators were generally inactive during transit.

Aphidoletes adults were released at six different areas in Oregon and Washington on chermes-infested subalpine fir (Abies lasiocarpa), Pacific silver fir (A. amabilis), or grand fir (A. grandis) (See table 5 in Appendix). Seven releases were free, and six were in cages. The type of cage used in 1959 was the same as that used in 1957 and 1958. Free releases were made by merely placing the box of predators at the base of a chermes-infested tree and removing the top.

Laboratory propagation - In an attempt to propagate Aphidoletes in the laboratory, 350 male and 495 female Aphidoletes were released on July 6 in a 24 x 25 x 33 inch screened cage containing two chermes-infested subalpine fir bolts. The caged bolts were situated in a sand table in a dimly lit room in the basement of the laboratory. Mean temperature during the study period was 70° F., and the relative humidity averaged 60 percent. Numerous progeny, in the larval stage, were found on the bolts when the cage was removed on July 22. Accurate larval counts were made on one bolt, and an estimate on the other. Results were as follows.

Bolt number	Center diameter	Length	Area (sq.in.)	Number of Aphidoletes larvae on bolt	Number of Aphidoletes Larvae per sq.in.
1	2.9 in.	29.3 in.	266	456	1.7
2	3.7 in.	32.5 in.	372	638 (est.)	1.7 (est.)

On July 23, the two bolts were taken to Green River, Washington, and placed at the base of a chermes-infested Pacific silver fir. Subsequent examination on August 13 revealed Aphidoletes larvae present on the release tree. The study showed that Aphidoletes can be successfully propagated in a small cage in the laboratory, and that they can be successfully transferred to the field in the larval stage and colonized.

Laricobius erichsonii Rosenh. (Coleoptera: Derodontidae)

Two shipments of these predators, totaling 1,640 specimens, were received. They were collected in the adult stage in the Black Forest of Germany by Dr. H. Zwölfer of the Commonwealth Institute of Biological Control and his assistants. The first shipment was sent by Air Freight from Basel, Switzerland, to Belleville via London and Montreal; the second shipment followed the same route except that it was sent from Stuttgart, Germany. Both shipments were sent to Portland from Belleville by Air Express and arrived in good condition. The shipping container used was the same type used in 1958. After arrival, the insects were stored in a refrigerator at 40° F. until time of release.

Eight hundred adults of the first shipment, which totaled 840 specimens, were released in a 6-foot square walk-in study cage located at Monroe, Oregon. The remaining 40 adults were kept at Corvallis, Oregon, for laboratory study.

The second shipment contained 800 adults and was released in an isolated young stand of grand fir on the Long Tom River, also near Monroe, Oregon. Predators had not been released in this stand previously, and chermes was present on the bole of several trees. It was thought that this stand, because of its isolated nature, would be especially good for observing localized dispersal and effectiveness of Laricobius.

Aphidecta obliterata L. (Coleoptera: Coccinellidae)

In 1959, one shipment containing 718 Aphidecta adults was received from Belleville (table 5, Appendix). These insects were collected in northern Germany and shipped as usual by Air Freight from Basel to Belleville via London and Montreal, and subsequently from Belleville to Portland.

The predators were released on May 16 at Wind River Arboretum, Washington, on a chermes-infested European silver fir (A. alba). The tree is situated in an area of several different species of Abies infested with chermes.

Cremifania nigrocellulata Cz. (Diptera: Chamaemyiidae)

Three shipments of this predator, totaling 989 adults, were received in 1959 (table 5, Appendix). The three lots were collected by Dr. Zwölfer in the Black Forest in Germany and arrived in Portland, via Belleville, on May 1, 6, and 15, respectively. Mortality of 12 and 50 percent, respectively, occurred in the first two shipments between Basel, Switzerland, and Belleville. There was additional mortality by the time they reached Portland. The third shipment arrived in good condition.

The first two shipments were released at Monroe, Oregon, on chermes-infested grand fir. Both free and cage releases were made. The third shipment was free-released at Corvallis, Oregon, also on grand fir.

Leucopis (Neoleucopis) n. sp. (Diptera: Chamaemyiidae)

Approximately 200 puparia of this predator were received from Pakistan via Belleville (table 5, Appendix). They were placed in rearing at the Forest Insect Laboratory, Oregon State College, Corvallis, Oregon. Only 15 adults were obtained, and these were cage-released on a chermes-infested grand fir at Monroe. The reason for poor emergence is not known. The puparia appeared to be in good condition on arrival, and no evidence of parasitism was seen.

Neoleucopis obscura (Hal.) (Diptera: Chamaemyiidae)

One shipment of 2085 specimens of Neoleucopis was received and released at Willamette Pass on June 3 (table 5, Appendix). The insects were released by both free and cage methods on heavily infested subalpine fir. The predators were provided by P. B. Dowden of the New Haven Forest Insect Laboratory of the Northeastern Forest Experiment Station. They were collected as puparia in Maine during the winter and placed in cold storage. In the spring the insects were removed to warmer temperatures and the adult flies allowed to emerge. They were then collected in pint ice-cream containers and sent by Air Freight from Milford, Connecticut to Portland, via New York City.

Scymnus (Diomus) pumilio (Wse.) (Coleoptera: Coccinellidae)

In 1959, 859 adults of this small coccinellid were added to the growing list of introduced foreign predators (table 5, Appendix). These insects were collected in Australia and sent to Belleville and then to Portland by Air Express. They were released on June 4 on a chermes-infested Pacific silver fir at Coldwater Creek, Washington.

Miscellaneous Coccinellidae

In September and October, six species of coccinellids were received from Pakistan and India via Belleville. Some species were collected as adults and some were reared from eggs in the originating countries by representatives of the Commonwealth Institute of Biological Control. A brief description of these shipments and their colonization follows (also see Appendix, table 5).

Exochomus uropygialis Muls. - Adults of this species were collected at Murree, Pakistan, and sent by Air Express from Rawalpindi to Belleville via Karachi, London and Montreal. On September 24, 316 specimens were released at Corvallis, Oregon, on a chermes-infested grand fir; on September 25, 1641 specimens were free released at Green River, Washington, on a Pacific silver fir.

Synharmonia conglobata L. - Three shipments of this insect were received. The adults were reared from eggs at the C.I.B.C. Laboratory at Bangalore, India, and sent to Belleville by Air Mail. Thirty adults of the first shipment were released on a subalpine fir at Santiam Pass, Oregon, the remaining 27 specimens were retained for laboratory experimentation. A second shipment, which contained 91 specimens was released on a Pacific silver fir at Randle, Washington. The third shipment contained 68 adults, but only five were alive on arrival in Portland. The dead insects were heavily covered with fungus, apparently due to excessive moisture in the shipping box. The survivors were used for the Station insect collection.

Adalia tetraspilota Hope var. bispilota Wse. - Three shipments of Adalia were received and released in Oregon in late September and early October. These predators were also reared from eggs at Bangalore and sent to Belleville then to Portland. The first shipment contained 21 adults and was released at Santiam Pass, Oregon. The second shipment of 55 adults was released on a chermes-infested Abies firma in Hoyt Arboretum, Portland. The final shipment, containing 17 specimens, was released on a moderately-infested grand fir in Helmick State Park near Monmouth, Oregon.

Ballia eucharis Muls. - One shipment of this species, containing 85 adults, was received. The insects were collected at Muree, Pakistan, and sent to Belleville by Air Express. This predator was released on a chermes-infested Pacific silver fir at Black Rock, Oregon on September 24.

Leis dimidiata F. - Two shipments of L. dimidiata were received. The adults of this species were reared from eggs at Bangalore and sent to Belleville via Air Mail. The first shipment of 15 was released on September 18 at Willamette Pass, Oregon; the second shipment of 9 was released on October 13 at Helmick State Park near Monmouth, Oregon.

Harmonia breiti Mader - Only one shipment of H. breiti was received. The 11 adults were reared from eggs at Bangalore and released on October 2 on a chermes-infested Abies korea in Hoyt Arboretum, Portland.

ESTABLISHMENT AND EFFECTIVENESS OF PREDATORS INTRODUCED SINCE 1957

As shown in table 4, fourteen species of foreign predators were released in Oregon and Washington from 1957 through 1959. Observations have been made of the success or failure of establishment since 1957. Some attempts have also been made to evaluate the effectiveness of the predators. The results of these observations and evaluations are summarized in table 10 in the Appendix. They are also discussed in the following sections.

Table 4.--Summary of foreign predators released in Oregon and Washington from 1957 through 1959

Species	Number released			Total
	1957	1958	1959	
Aphidoletes thompsoni	1,830	2,480	29,894	34,204
Laricobius erichsonii	--	8,525	1,600	10,125
Neoleucopis obscura	--	700	2,085	2,785
Exochomus uropygialus	--	--	1,957	1,957
Aphidecta obliterata	--	720	718	1,438
Cremifania nigrocellulata	--	385	989	1,374
Scymnus (Diomus) pumilio	--	--	859	859
Chilocorus kuwanae	--	135	--	135
Synharmonia conglobata	--	--	121	121
Adalia tetraspilota var. bispilota	--	--	89	89
Ballia eucharis	--	--	85	85
Leis dimidiata	--	--	23	23
Leucopis (Neoleucopis) n. sp.	--	--	15	15
Harmonia breiti	--	--	10	10
Totals	1,830	12,945	38,445	53,220

Aphidoletes thompsoni

This was the first foreign predator received and released in the Pacific Northwest. During the period from 1957 through 1959, 34,204 Aphidoletes adults were released. This predator has been one of the most successful species in establishing itself in the Region (table 10 Appendix). In 1959, progeny were abundant at one of the three 1957 release areas, in the one 1958 release area, and at five of the six 1959 release areas.

Detailed observations on dispersal following establishment have not been made. However, progeny have been found as much as 100 feet from the release tree within three months after release.

When Aphidoletes larvae are abundant on trees heavily infested with C. piceae, their presence is quite apparent. This is caused by the predator larvae feeding and wandering under the chermes wool, causing it to separate to some degree from the bark and giving it a fluffed-up appearance. The effectiveness of predation on a quantitative basis has not been determined.

It can be concluded from observations over the 3-year period that (1) Aphidoletes is now well established in Oregon and Washington, and (2) it appears promising as a biological control agent of the balsam woolly aphid.

Laricobius erichsonii

General observations - Since 1958, 10,125 Laricobius adults have been released in Oregon and Washington. This predator has overwintered successfully at five of the six 1958 release areas. The only release area where the predator has not shown positive signs of establishment is at Corvallis, and there is some evidence it also may have survived there (table 10, Appendix).

The two releases in 1959 have resulted in at least temporary establishment. Larvae were found attacking chermes on the release trees in both areas, and cast larval skins of Laricobius were found on several adjacent chermes-infested trees.

In the areas where Laricobius have survived at least one full season, larvae and adults were found attacking chermes on trees as far as 75 feet from the original release trees.

Laricobius tears up the chermes wax or "wool" while searching for prey material. After an attack by these predators, chermes' eggs shrivel up and darken from orange to a light brown. Attacked egg masses can be spotted immediately due to this characteristic appearance.

It appears that Laricobius is able to survive and reproduce in the Pacific Northwest. Whether this predator can reduce chermes populations to the extent that mass tree-killing will be prevented is unknown, although present indications are that it is capable of reducing populations considerably.

Special field study in 1959 - The purpose of this study was to investigate the biology of Laricobius in its new habitat, and to assess its effectiveness as a predator. On May 2, 800 adults were released in a six-foot-square walk-in study cage at Monroe, Oregon (figure 1). The cage enclosed the basal 6 feet of a grand fir heavily infested by the balsam woolly aphid. Diameter of the tree was 6.8 inches at breast height.

Figure 1.--Walk-in study cage in grand fir woodlot at Monroe, Oregon.

The method of evaluating predator effectiveness was modified from the system designed by N. R. Brown and R. C Clark at the Fredericton, New Brunswick, Forest Biology Laboratory. A five-foot section of the bole of the study tree was marked off and divided with vertical string lines into four quadrants. Within each quadrant, two plots were established -- at 6 inches and at 36 inches from the top of the study area. These particular plot locations were chosen for two reasons: (1) it was thought that the greatest variety of prey populations could be sampled; and (2) the locations allowed comfortable positions for making the tedious detailed population counts -- an important consideration in obtaining accurate data. Two of the 8 plots were randomly designated as check, or protected, plots and were covered with small screen cages to exclude Laricobius.

At the time of each evaluation, an aluminum template with a one-inch-square opening was hung on two nails which had been permanently driven into the tree directly above each plot. This created a permanent sampling area without materially affecting the aphid population. The number of eggs, crawlers, dormant neosistentes, intermediate stages, and adults of the balsam woolly aphid on the plots were counted at approximately two week intervals on each of the eight plots. Counts were made with a microscope mounted on an elevator-type camera tripod (figure 2). The tripod steadied the microscope and left the hands free for probing, when necessary.

The number of adult Laricobius within the entire five-foot study section also was tallied at the time of each examination. The limited time available prevented a larval count.

The study cage served to exclude all other native or foreign predators as well as limit the dispersal of the 800 Laricobius adults.

The first evaluation was made on May 1, one day before the predators were released in the cage. With the exception of the period between June 11 and July 21, the plots were evaluated approximately bi-weekly through November 23. Examinations were missed during the indicated period because of the demands of rearing and releasing Aphidoletes.

Figure 2.--Rating effectiveness of foreign predators with a microscope mounted on camera tripod.

On June 11, a cast larval skin of Laricobius was found on one of the protected plots. Consequently, the counts on that plot were not used in the final evaluation.

The periodic differences between the adult chermes populations on the protected and unprotected plots are shown graphically in figure 3. It is apparent that predation by Laricobius greatly influenced the balsam woolly aphid population -- the adult chermes population on the unprotected plots decreasing noticeably following release of the predators, while the population on the protected plots increased.

The greatest reduction in chermes population on the unprotected plots occurred during the early part of the season, when it is normally near its lowest point. Reducing the aphid population at this time should minimize damage to the host for the remainder of the present growing season, and possibly longer. Host relationship studies on this point are needed.

Aphidecta obliterata

In 1958 and 1959, 1,438 adults of this coccinellid were released in the Pacific Northwest (table 10, Appendix). The 1958 release trees at Green River, Washington, and Corvallis, Oregon, show no signs of establishment of this predator, although Aphidecta eggs were collected at Green River several weeks following release and were hatched in the laboratory. By 1959, the tree at Green River had been felled by logging, and the Corvallis release tree had only a light chermes population. Subsequent searches on adjacent trees in the two areas showed no signs of the predator.

Aphidecta progeny, both larvae and adults, were recovered at Wind River, Washington, following the 1959 release. On July 31, two progeny adults were seen mating on the release tree, and several other adults were observed feeding.

The chermes population on the release tree at Wind River was reduced noticeably by the preying of Aphidecta. The population on the release tree, which originally had a heavy bole population of approximately 50 C. piceae per square inch, was reduced to about five per square inch by the end of August. Much of the reduction was believed due to the preying of Aphidecta, because either larvae or adults were seen on the tree throughout the summer.

In case it overwinters successfully at Wind River, an attempt will be made to determine the habits of Aphidecta in the Pacific Northwest.

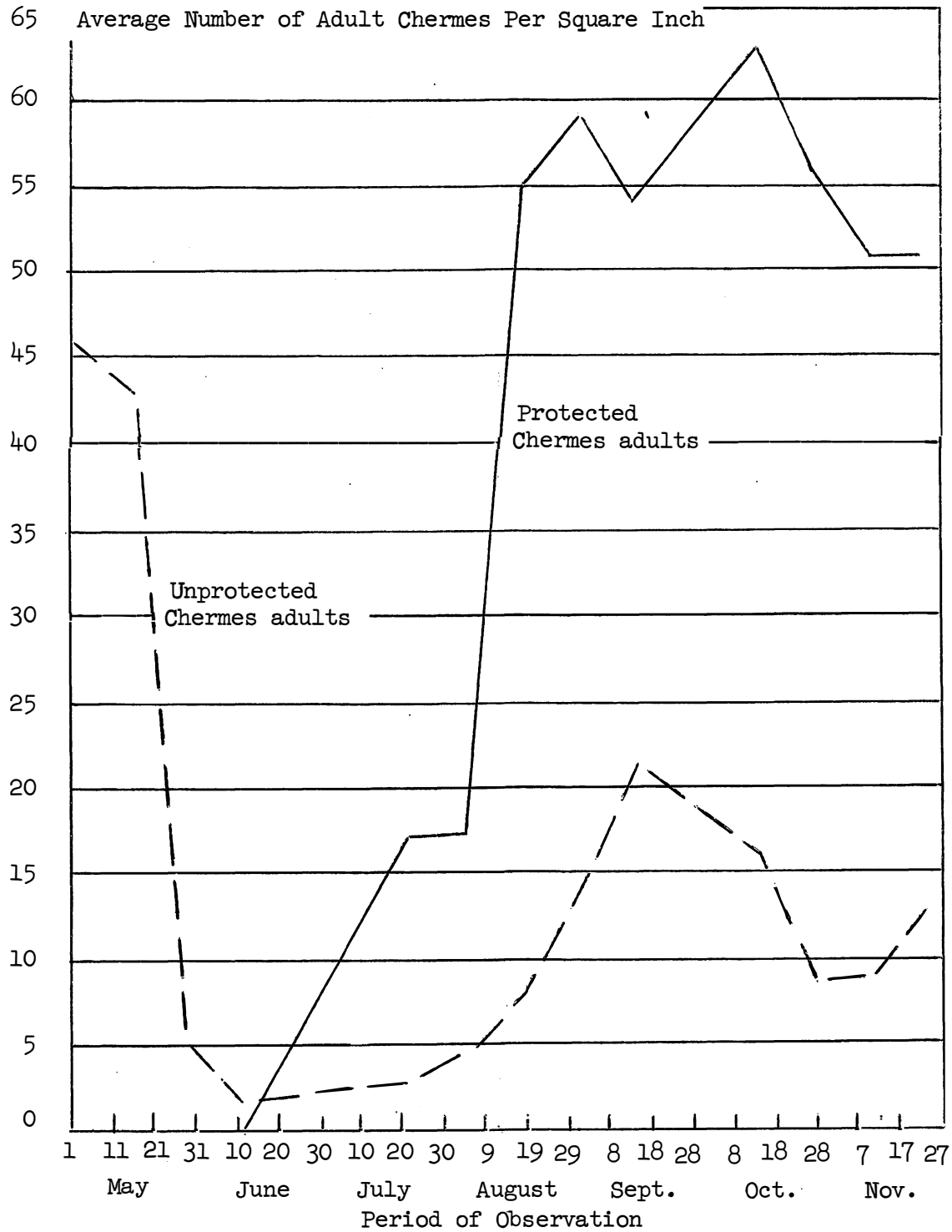

Figure 3.-1959 population trend of Chermes adults on sample plots protected or not protected from predation by Laricobius erichsonii. (Study tree at Monroe, Oregon.)

Chilocorus kuwanae (Coleoptera: coccinellidae)

In 1958, this predator was released at Cold Water Creek, Washington, and at Monroe, Oregon. It was also released under controlled conditions in the laboratory. Subsequent checks, both in 1958 and 1959, failed to reveal either larvae or adults associated with Chermes piceae in the release areas or on laboratory-caged logs. It appears that the balsam woolly aphid is completely unacceptable as prey for Chilocorus, even though in Japan the predator attacks a close relative, Chermes todomatsui Inouye.

Cremifania nigrocellulata

In 1958 and 1959, a total of 1,374 Cremifania adults were released in three areas in western Oregon. Two larvae were found shortly after the 1958 liberation at Willamette Pass. The release tree died in early 1959 and no more larvae were found, even though limited searches were made on adjacent trees. A more intensive search is planned for 1960.

It appears that two generations of Cremifania were obtained from the 1959 liberation at Monroe. Vacated puparia were found in early summer, and early instar larvae were collected in late summer and fall. Mature larvae were also found at Corvallis although they were considerably less abundant than at Monroe. The Corvallis liberation was the only one in which progeny were obtained from a free release. The successful liberations at Monroe and Willamette Pass were both cage releases.

Leucopis (Neoleucopis) sp.

No evidence of establishment of this fly from Pakistan has been found since its release in 1959. Because of the small number released (15 adults), the likelihood of establishment is not good.

Neoleucopis obscura

During the past two summers, 2,785 adults of Neoleucopis were released in the Pacific Northwest. The 1958 release tree at Green River, Washington, was felled by logging, and no evidence of the predators has been found on adjacent trees, although a thorough search has been made. At Willamette Pass, Oregon, several larvae of N. obscura were collected following release in 1959. These were compared with specimens sent to the Station by the Canadians in order to insure accurate identification. In the field, it was difficult to distinguish N. obscura from native species of Leucopis.

Scymnus (Diomus) pumilio

This species has not been recovered. The 1959 release tree at Coldwater Creek, Washington, developed secondary periderm early in the summer, killing the bulk of the host population and decreasing the likelihood of establishment. It is possible that the predator became established on other chermes-infested trees in the area, although limited observations failed to reveal any sign of it.

Miscellaneous Coccinellidae

Only limited observations were made on these six species of predators following their release in late September and early October (table 10, Appendix). Only one species, Exochomus uropygialus, was seen actually feeding on C. piceae. Also, it was the only species found on its release tree as long as 3 weeks after release. There is considerable doubt whether any of the six predators had time to mate and produce brood before cold weather set in.

PROJECT PERSONNEL

The predator introduction and colonization project was under the general supervision of entomologist K. H. Wright of the Division of Forest Insect Research of the Pacific Northwest Forest and Range Experiment Station. Immediate responsibility for laboratory rearing, handling, and releasing the insects was shared by Wright, R. G. Mitchell, and P. E. Buffam, entomologists. Buffam and Mitchell made most of the post-release examinations. Biological Aids J. C. Neeley and J. N. Owens assisted in rearing and releasing the predators, and in examining the release areas; they also constructed some of the special equipment used. Entomologist W. H. Klein also assisted in some of the releasing. N. E. Johnson, entomologist of Weyerhaeuser Company, Centralia, Washington; and Dr. J. A. Rudinsky of Oregon State College were helpful in supplying technical and field assistance of various kinds.

Table 5.--Shipments and colonizations of foreign predators of the balsam woolly aphid in 1959

Species	Source	Shipment no. and no. of predators	Shipment date, place, and carrier	Arrival date in Portland	Condition on arrival	Date of release	Location of release	No. released [1]	Temperature	Type of release	Host pop. on release tree	Species of Release tree	Released by
Aphidoletes thompsoni	Czechoslovakia	1 - 30,000	6/13 - Belleville, Ont. Air Express [2]	6/15	Good	6/22	Willamette Pass, Oreg.	264	70° F.	Cage	Heavy	Abies lasiocarpa	Mitchell, Owens, Buffam
						6/29	Willamette Pass, Oreg.	553	70° F.	Cage	Heavy	A. lasiocarpa	Buffam
(Received as larvae and pupae--reared, and released as adults)						6/30	Willamette Pass, Oreg.	238	54° F.	Cage	Heavy	A. lasiocarpa	Mitchell
						7/ 2	Willamette Pass, Oreg.	136	68° F.	Free	Heavy	A. lasiocarpa	Buffam
	Germany	2 - 56,000	6/29 - Belleville, Ont. Air Express	7/1	Good	7/ 3	Willamette Pass, Oreg.	4444	64° F.	Free	Heavy	A. lasiocarpa	Mitchell
						7/ 4	Black Rock, Oreg.	2466	64° F.	Cage	Medium	A. amabilis	Buffam
						7/ 6	Willamette Pass, Oreg.	3527	58° F.	Cage	Heavy	A. lasiocarpa	Buffam
						7/ 6	Sellwood Lab.	845 [3]	--	Cage	Heavy	A. lasiocarpa	--
						7/ 9	Coldwater Cr., Wn.	2436	72° F.	Free	Heavy	A. amabilis	Klein, Buffam
						7/11	McKenzie Pass, Oreg.	991	82° F.	Cage	Heavy	A. lasiocarpa	Buffam
						7/14	Black Rock, Oreg.	5507	64° F.	Free	Medium	A. amabilis	Mitchell, Buffam
						7/16	Randle, Wn.	1076	73° F.	Cage	Heavy	A. amabilis	Buffam
						7/21	Monroe, Oreg.	113	80° F.	Free	Heavy	A. grandis	Neeley, Buffam
	Germany	3 - 31,000	7/ 6 - Belleville, Ont. Air Express	7/8	Fair (Est. 50% mortality at time of collection)	7/ 9	Coldwater Cr., Wn.	887	72° F.	Free	Heavy	A. amabilis	Klein, Buffam
						7/11	McKenzie Pass, Oreg.	2859	82° F.	Free	Heavy	A. lasiocarpa	Buffam
						7/14	Black Rock, Oreg.	2522	64° F.	Free	Medium	A. amabilis	Mitchell, Buffam
						7/16	Randle, Wn.	986	73° F.	Cage	Heavy	A. amabilis	Buffam
						7/21	Monroe, Oreg.	44	80° F.	Free	Heavy	A. grandis	Neeley, Buffam
	Subtotals	117,000						29,894					

Table 5.--Shipments and colonizations of foreign predators of the balsam woolly aphid in 1959 (Cont'd.)

Species	Source	Shipment No. and no. of predators	Shipment date, place, and carrier	Arrival date in Portland	Condition on arrival	Date of release	Location of release	No. released [1]	Temperature	Type of release	Host pop. on release tree	Species of release tree	Released by
Aphidecta obliterata (adults)	Germany	1 - 718	5/13- Belleville, Ont. Air Express	5/15	Good - Est. 2% mort.	5/16	Wind River, Wn.	718	60° F.	Free	Heavy	Abies alba	Wright
	Subtotals	718						718					
Cremifania nigrocellulata (adults)	Germany	1 - 550	4/29 do.	5/ 1	Good - Est. 7% mort.	5/ 2	Monroe, Oreg.	550	57° F.	Free & cage	Heavy	A. grandis	Mitchell, Buffam
		2 - 280	5/ 4 do.	5/ 6	Fair	5/ 7	Monroe, Oreg.	280	68° F.	Cage	Heavy	A. grandis	Wright, Mitchell
		3 - 159	5/13 do.	5/15	Excellent	5/15	Corvallis, Oreg.	159	57° F.	Free	Heavy	A. grandis	Wright
	Subtotals	989						989					
Laricobius erichsonii (adults)	Germany	1 - 840	4/29 do.	5/ 1	Fair - Est. 10% mort.	5/ 2	Monroe, Oreg.	800 [4]	57° F.	Cage	Heavy	A. grandis	Mitchell, Buffam
		2 - 800	5/ 4 do.	5/ 6	Good	5/ 7	Long Tom R., Oreg.	800	68° F.	Free	Moderate	A. grandis	Wright, Mitchell
	Subtotals	1640						1600					
Leucopis (Neoleucopis) n. sp. (Received as pupae - reared and released as adults)	Pakistan	1 - 200 (approx.)	5/ 4- Belleville, Ont. Air Express	5/ 6	Poor - Est. over 20% mort.	5/28	Monroe, Oreg.	15	68° F.	Cage	Heavy	A. grandis	Buffam
	Subtotals	200						15					
Neoleucopis obscura (adults)	Maine	1 - 2085	6/ 2 do.	6/ 3	Excellent	6/ 3	Willamette Pass, Oreg.	2085	65-70°F.	Free & cage	Heavy	A. lasiocarpa	Wright, Mitchell, Buffam
	Subtotals	2085						2085					
Scymnus (Diomus) pumilio (adults)	Australia	1 - 859	6/ 2 do.	6/ 4	Good - Est. 5% mort.	6/ 4	Coldwater Cr., Wn.	859	55° F.	Free	Heavy	A. amabilis	Wright
	Subtotals	859						859					

Table 5.--Shipments and colonizations of foreign predators of the balsam woolly aphid in 1959 (Cont'd.)

Species	Source	Shipment no. and no. of predators	Shipment date, place, and carrier	Arrival date in Portland	Condition on arrival	Date of release	Location of release	No. released 1/	Temperature	Type of release	Host pop. on release tree	Species of release tree	Released by
Adalia tetraspilota Hope Var. bispilota Wse. (adults)	India	1 - 21	9/15- Belleville, Ont. Air Express	9/17	Excellent	9/18	Santiam Pass, Oreg.	21	45° F.	Free	Moderate	A. lasiocarpa	Wright
		2 - 55	9/30 do.	10/ 2	Good - 1 dead	10/ 2	Portland,Oreg.	54	70° F.	Free	Moderate	A. firma	Mitchell
		3 - 17	10/ 7 do.	10/12	Good - 3 dead	10/13	Monmouth,Oreg.	14	55° F.	Free	Moderate	A. grandis	Mitchell
	Subtotals	93						89					
Synharmonia conglobata L. (adults)	India	1 - 57	9/15 do.	9/17	Excellent	9/18	Santiam Pass, Oreg.	30 5/	48° F.	Free	Heavy	A. lasiocarpa	Wright
		2 - 91	9/21 do.	9/23	Excellent	9/25	Randle, Wn.	91	45° F.	Free	Heavy	A. amabilis	Mitchell
		3 - 68	10/ 7- Belleville, Ont. Air Mail	10/12	Poor - 5 alive			6/					
	Subtotals	216						121					
Exochomus uropygialus Muls. (adults)	Pakistan	1 - 1641	9/21 do.	9/23	Excellent	9/25	Green R., Wn.	1641	56° F.	Free	Heavy	A. amabilis	Mitchell, Johnson
		2 - 316	9/21 do.	9/23	Excellent	9/24	Corvallis, Oreg.	316	60° F.	Free	Heavy	A. grandis	Mitchell
	Subtotals	1957						1957					
Ballia eucharis Muls. (adults)	Pakistan	1 - 85	9/21 do.	9/23	Excellent	9/24	Black Rock, Oreg.	85	56° F.	Free	Moderate	A. amabilis	Mitchell
	Subtotals	85						85					
Leis dimidiata F. (adults)	India	1 - 15	9/15 do.	9/17	Excellent	9/18	Willamette Pass, Oreg.	15	50° F.	Cage	Heavy	A. lasiocarpa	Wright
		2 - 9	10/ 7 do. Air Mail	10/12	Good	10/13	Monmouth, Oreg.	8	55° F.	Free	Moderate	A. grandis	Mitchell
	Subtotals	24						23					
Harmonia breiti Mader	India	1 - 11	9/30 do.	10/ 2	Good	10/ 2	Portland,Oreg.	10	70° F.	Free	Heavy	A. korea	Mitchell
	Subtotals	11						10					
	Totals	125,877						38,445					

1/ Some numbers not corrected for mortality, because of its very low incidence, and the urgency for prompt release.

2/ Shipments from Belleville travelled by train to Toronto, then Air Express to Portland.

3/ These adults used for laboratory rearing experiment at Sellwood.

4/ Forty adults kept at Corvallis for experimental use.

5/ Twenty-seven adults used for laboratory experiment.

6/ Survivors used for Station collection.

Table 6.--Summary of 1959 rearings of Aphidoletes thompsoni--
Shipment No. 1

Cage number	Number Aphidoletes emerging--by dates: June 20	21	22	23	24	25	26	27	28	29	30	July 1	2	Total emergence	Grams of rearing mat.	Emergence per gram
Males																
1	2	-	-	-	-	-	-	2	3	3	2	2	1	15	87.1	0.17
2	3	-	-	-	-	-	-	10	18	10	2	-	-	43	86.1	0.50
3	-	1	-	-	-	-	-	2	5	7	1	1	-	17	80.7	0.21
4	3	-	-	-	-	-	1	5	19	10	3	-	-	41	84.0	0.49
5	3	-	-	-	-	-	-	8	13	9	1	2	-	36	89.5	0.40
6	2	1	-	-	-	-	2	4	13	13	4	3	-	42	88.7	0.47
7	2	-	-	-	-	-	1	6	13	14	2	-	-	38	93.7	0.41
8	1	-	-	-	-	-	-	2	4	5	2	1	-	15	84.3	0.18
9	1	-	-	-	-	-	-	3	7	3	-	-	-	14	80.0	0.18
10	-	-	-	-	-	-	1	1	4	6	-	-	-	12	84.6	0.14
Total males	17	2	-	-	-	-	5	43	99	80	17	9	1	273	858.7	0.32
Females																
1	14	6	3	-	-	-	-	7	16	21	7	2	4	80	87.1	0.92
2	24	8	4	-	-	-	3	20	24	36	7	6	-	132	86.1	1.53
3	13	5	1	-	-	-	1	14	12	16	8	3	2	75	80.7	0.93
4	21	10	2	-	-	-	-	15	39	24	5	3	-	119	84.0	1.42
5	18	4	1	-	-	-	1	15	31	22	4	6	2	104	89.5	1.16
6	18	9	2	-	-	3	3	11	30	25	10	8	-	119	88.7	1.34
7	20	5	2	-	-	-	4	12	30	24	6	8	1	112	93.7	1.20
8	17	7	3	-	-	-	1	5	16	18	8	4	1	80	84.3	0.95
9	16	3	3	-	-	-	1	2	11	10	1	-	-	47	80.0	0.59
10	9	3	2	-	-	-	-	6	12	15	3	-	-	50	84.6	0.59
Total females	170	60	23	-	-	3	14	107	221	211	59	40	10	918	858.7	1.07
Total males and females	187	62	23	-	-	3	19	150	320	291	76	49	11	1191	858.7	1.39

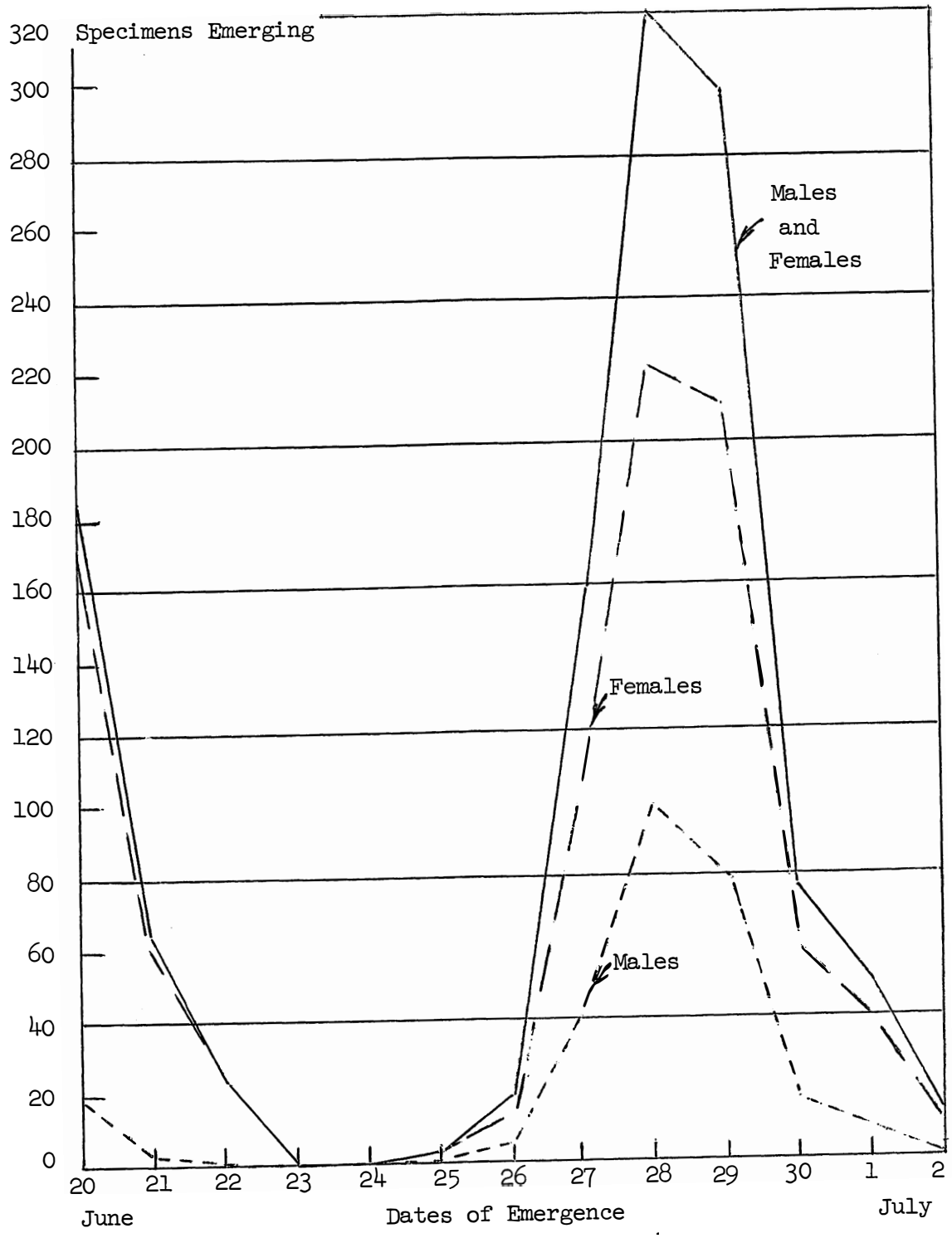

Figure 4.-Emergence of Aphidoletes thompsoni adults from shipment number 1. Sellwood Laboratory, 1959.

Table 7.--Summary of 1959 rearings of Aphidoletes thompsoni--
Shipment No. 2

Cage number	Number Aphidoletes emerging in July, by dates															Total emergence	Grams of rearing mat.	Emergence per gram
	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16			
Males																		
1	87	86	40	26	11	11	5	-	-	-	-	-	-	-	-	266	128.0	2.08
2	100	105	64	32	30	15	6	-	-	-	-	-	-	-	-	352	143.7	2.45
3	117	86	61	27	14	16	1	1	-	-	-	-	-	-	-	323	111.0	2.91
4	37	84	97	40	59	63	31	14	39	112	167	74	35	14	1	867	148.8	5.83
5	-	51	43	31	26	33	18	12	21	60	82	41	14	6	2	440	130.8	3.36
6	-	1	-	11	27	32	17	11	10	36	89	30	6	5	-	275	129.6	2.12
7	-	-	2	58	75	142	112	36	52	145	208	129	65	19	1	1044	144.6	7.22
8	-	-	-	16	20	48	24	14	14	47	109	55	21	9	2	379	115.3	3.29
9	2	20	24	18	38	12	7	1	-	16	16	10	5	9	3	181	166.0	1.09
10	99	98	57	34	35	26	6	8	12	58	107	54	33	13	3	643	128.5	5.00
11	146	97	40	27	20	12	5	1	-	-	-	-	-	-	-	348	123.5	2.82
12	147	84	44	19	18	17	3	-	-	-	-	-	-	-	-	332	129.7	2.56
13	8	43	28	18	9	5	-	-	-	16	12	28	8	9	2	186	143.5	1.30
14	199	144	60	19	22	16	7	2	-	-	-	-	-	-	-	469	158.6	2.96
15	42	78	64	33	36	40	11	5	8	42	73	46	26	16	3	523	139.5	3.75
16	78	89	72	38	56	29	8	7	17	67	124	54	32	19	3	693	157.3	4.41
17	2	23	13	9	22	7	8	7	5	26	35	41	11	6	1	216	144.1	1.50
18	5	40	23	19	25	26	12	12	11	38	71	50	18	6	3	359	142.3	2.52
19	-	-	-	5	21	30	-	3	7	45	-	22	14	2	-	149	121.2	1.23
Total males	1,069	1,129	732	480	564	580	281	134	196	708	1,093	634	288	133	24	8,045	2,606.0	3.09
Females																		
1	151	156	102	69	30	42	12	-	-	-	-	-	-	-	-	562	128.0	4.39
2	193	169	104	80	16	23	19	1	-	-	-	-	-	-	-	605	143.7	4.21
3	230	190	105	101	34	46	11	3	-	-	-	-	-	-	-	720	111.0	6.49
4	61	124	130	107	134	99	42	37	44	130	239	140	48	28	11	1,374	148.8	9.23
5	-	45	80	65	67	58	29	18	24	79	112	84	27	18	3	709	130.8	5.42
6	-	-	-	6	37	60	18	19	23	43	102	41	15	9	3	376	129.6	2.90
7	-	-	-	47	115	244	181	89	66	163	288	182	74	48	17	1,514	144.6	10.47
8	-	-	-	2	33	86	74	28	38	53	137	106	28	13	6	604	115.3	5.24
9	2	30	23	31	44	18	8	2	-	18	27	9	7	4	5	228	166.0	1.37
10	188	190	92	72	72	45	27	13	25	73	90	88	44	32	12	1,063	128.5	8.27
11	321	202	90	53	42	19	11	3	-	-	-	-	-	-	-	741	123.5	6.00
12	317	222	84	34	31	9	3	-	-	-	-	-	-	-	-	700	129.7	5.40
13	16	54	39	23	30	11	8	4	1	18	5	49	7	7	5	277	143.5	1.93
14	376	282	157	55	51	29	19	2	-	-	-	-	-	-	-	971	158.6	6.12
15	83	114	97	76	93	45	26	21	7	65	100	71	30	37	10	875	139.5	6.27
16	152	150	122	86	70	52	35	20	25	84	137	98	44	44	7	1,126	157.3	7.16
17	1	20	22	19	21	21	9	6	1	22	35	38	11	11	1	238	144.1	1.65
18	3	34	38	29	35	35	39	18	17	23	83	77	35	21	4	491	142.3	3.45
19	-	-	1	1	41	47	-	15	11	30	-	24	9	2	5	186	121.2	1.53
Total females	2,094	1,982	1,286	956	996	989	571	299	282	801	1,355	1,007	379	274	89	13,360	2,606.0	5.13
Total males & females	3,163	3,111	2,018	1,436	1,560	1,569	852	433	478	1,509	2,448	1,641	667	407	113	21,405	2,606.0	8.22

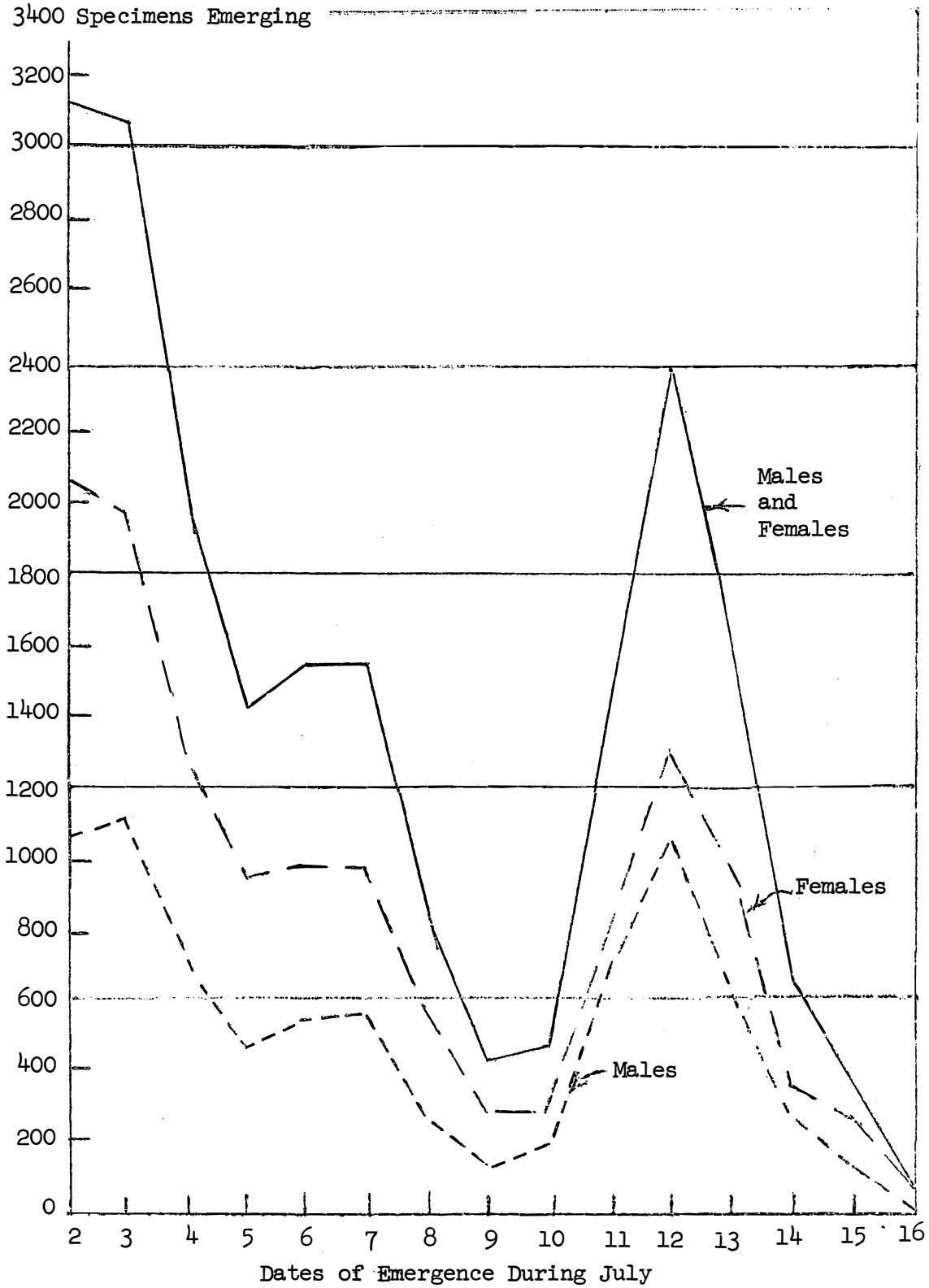

Figure 5.-Emergence of Aphidoletes thompsoni adults from shipment Number 2. Sellwood Laboratory, 1959.

Table 8.--Summary of 1959 rearings of Aphidoletes thompsoni--
Shipment No. 3

Cage number	Number Aphidoletes emerging in July, by dates									Total emergence	Grams of rearing mat.	Emergence per gram
	8	9	10	11	12	13	14	15	16			
					Males							
21	42	69	77	43	45	76	49	11	4	416	116.1	3.58
22	87	96	54	46	28	32	23	12	1	379	148.7	2.55
23	23	77	64	38	39	72	41	5	2	361	138.3	2.61
24	137	115	56	59	-	21	39	9	-	436	154.6	2.82
25	9	37	27	11	18	16	14	1	2	135	124.2	1.09
26	11	72	59	23	38	77	46	7	1	334	165.2	2.02
27	43	53	38	18	17	9	8	9	2	197	140.4	1.40
28	26	38	18	19	9	11	11	7	1	140	145.2	0.96
29	15	12	20	6	6	7	1	3	1	71	123.6	0.57
30	71	83	63	22	23	27	28	7	2	326	135.3	2.41
Total males	464	652	476	285	223	348	260	71	16	2795	1391.6	2.01
					Females							
21	7	73	141	135	53	85	84	30	3	611	116.1	5.26
22	26	157	166	122	44	31	44	15	3	608	148.7	4.09
23	4	63	146	120	57	95	86	42	4	617	138.3	4.46
24	29	164	174	149	-	41	51	25	3	636	154.6	4.11
25	8	13	59	39	15	35	26	25	1	221	124.2	1.78
26	-	62	153	125	37	107	67	45	8	604	165.2	3.66
27	14	81	86	87	21	24	17	14	-	344	140.4	2.45
28	19	54	45	49	24	18	11	2	-	222	145.2	1.53
29	11	19	33	32	10	12	5	3	1	126	123.6	1.02
30	18	104	160	93	39	41	34	20	5	514	135.3	3.80
Total females	136	790	1163	951	300	489	425	221	28	4503	1391.6	3.24
Total males & females	600	1442	1639	1236	523	837	685	292	44	7298	1391.6	5.25

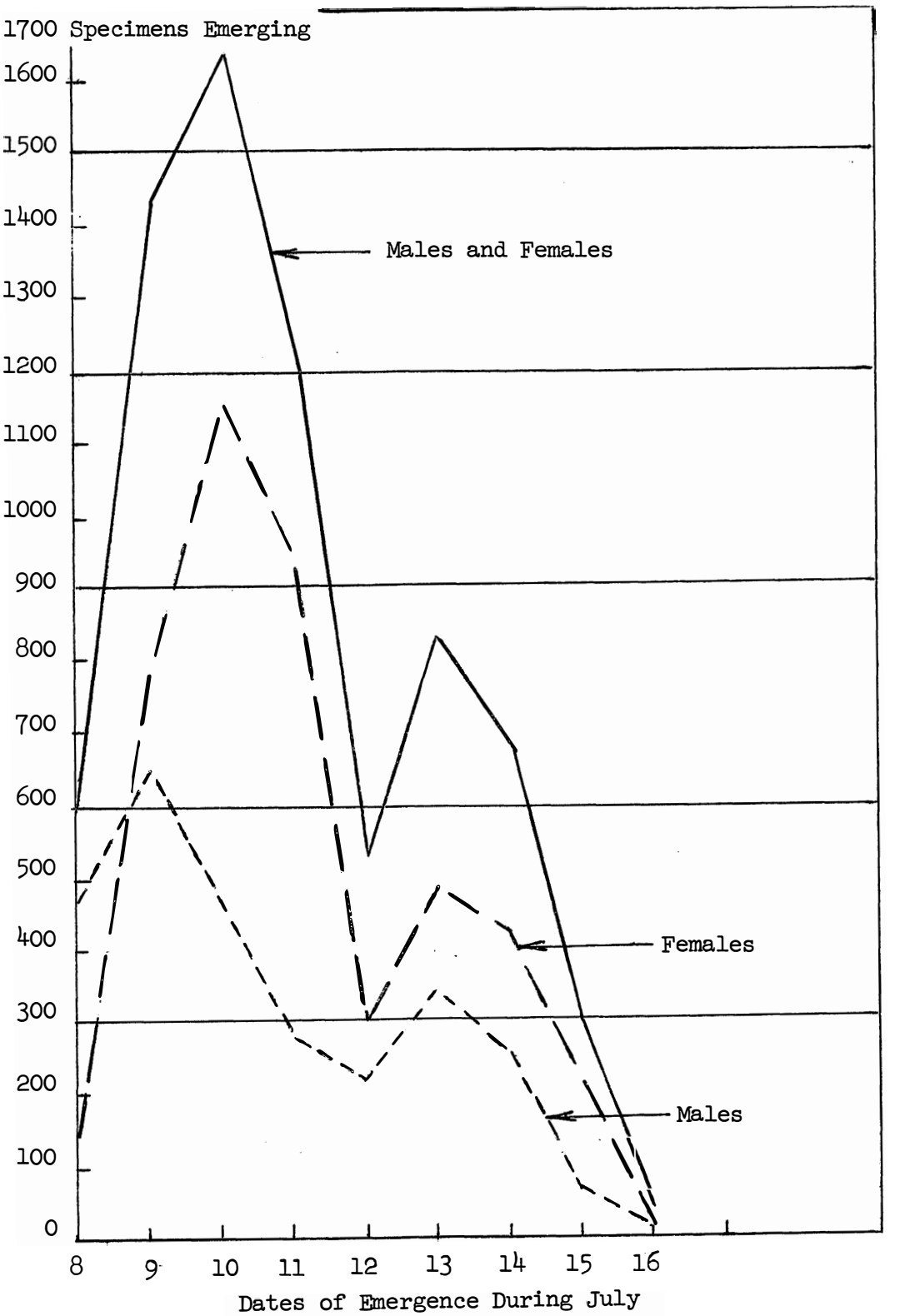

Figure 6.-Emergence of Aphidoletes thompsoni adults from shipment number 3. Sellwood Laboratory, 1959.

Table 9.--Summary of proctotrupid parasite emergence from Aphidoletes rearings of shipments 1, 2, and 3 -- Sellwood Laboratory, 1959

Shipment No. 1

Cage	No. of proctotrupids emerging by date: June 29	June 30	July 1	July 2	Total
1	-	2	1	3	6
2	-	3	1	1	5
3	-	-	1	-	1
4	1	5	5	1	12
5	-	2	6	2	10
6	-	1	2	-	3
7	-	1	4	-	5
8	-	-	-	-	-
9	-	-	-	-	-
10	-	1	-	-	1
Total	1	15	20	7	43

Shipment No. 2

Cage	No. of proctotrupids emerging in July, by dates: 6	7	8	9	10	11	12	13	14	15	16	Total
1	1	3	17	2	-	-	-	-	-	-	-	23
2	-	13	11	6	-	-	-	-	-	-	-	30
3	1	9	5	5	-	-	-	-	-	-	-	20
4	-	2	2	-	15	17	40	19	65	31	14	205
5	-	-	-	1	8	13	6	4	29	7	17	85
6	-	-	-	1	-	-	-	3	22	18	29	73
7	-	-	-	-	-	-	10	15	50	67	61	203
8	-	-	-	-	-	-	-	4	32	30	27	93
9	-	-	-	-	-	4	4	-	3	1	-	12
10	-	4	4	6	15	22	34	9	42	13	8	157
11	-	-	10	-	-	-	-	-	-	-	-	10
12	-	-	16	-	-	-	-	-	-	-	-	16
13	-	-	-	-	1	1	4	5	3	1	-	15
14	-	2	10	8	-	-	-	-	-	-	-	20
15	-	-	3	8	10	29	17	22	23	10	10	132
16	-	1	2	11	17	41	57	14	27	31	2	203
17	-	-	-	-	1	11	15	13	24	9	14	87
18	-	-	-	-	1	8	21	9	6	12	20	77
19	-	-	-	-	-	-	-	-	5	3	3	11
Total	2	34	80	48	68	146	208	117	331	233	205	1472

Shipment No. 3

Cage	No. of proctotrupids emerging in July, by dates: 8	9	10	11	12	13	14	15	16	Total
21	-	-	-	-	-	-	-	-	2	2
22	-	-	-	-	-	-	1	-	-	1
23	-	-	-	-	-	-	-	5	1	6
24	-	-	-	-	-	-	-	1	-	1
25	-	-	2	8	-	5	8	1	3	27
26	-	-	-	-	-	-	-	5	-	5
27	-	1	-	1	-	-	2	1	-	5
28	-	-	-	-	-	2	-	-	-	2
29	1	-	-	1	1	-	-	-	-	3
30	-	-	-	-	-	-	-	-	-	-
Total	1	1	2	10	1	7	11	13	6	52

Table 10.--Summary of foreign predator releases and observations from 1957 through 1959

Year of Release	Species Released	Release area	No. released (adults)	1957 observations	1958 observations	1959 observations
1957	Aphidoletes thompsoni	Black Rock, Ore.	1025	No evidence of establishment.	No evidence of establishment..	No evidence of establishment.
		Toutle River, Wn.	605	No evidence of establishment.	Larvae numerous on one release tree in August and September.	Larvae found on trees up to 75 ft. from original release tree in July and August.
		Corvallis, Ore.	200	No evidence of establishment.	No evidence of establishment.	No evidence of establishment.
1958	Aphidecta obliterata	Corvallis, Ore.	395		No evidence of establishment.	No evidence of establishment.
		Green River, Wn.	325		A few larvae observed following release; nothing found later.	No evidence of establishment; release tree dead and felled by logging.
	Aphidoletes thompsoni	Monroe, Ore.	2480		A few larvae found on release tree in August and September.	Release tree prey population small; numerous larvae found on trees up to 100 ft. from release tree in July through September.
	Chilocorus kuwanae	Monroe, Ore.	55		No evidence of establishment.	No evidence of establishment.
		Coldwater Cr., Wn.	80		No evidence of establishment.	No evidence of establishment.
	Cremifania nigrocellulata	Willamette Pass, Ore.	385		Found only 3 larvae on the bole of the release tree.	Release tree dead; no evidence of establishment.
	Laricobius erichsonii	Black Rock, Ore.	1550		Numerous larvae on both release trees in July.	Numerous larvae found on several trees from 5-40 ft. from release trees in June and July.
		Corvallis, Ore.	1705		Larvae found on one of the two release trees and on several other trees in the vicinity in June and July.	No evidence of establishment; but observations made too late for accurate assessment.
		Willamette Pass, Ore.	1200		A few larvae and adults observed on release tree in July.	Larvae and adults on many trees in area; spreading up to 75 ft.
		Coldwater Cr., Wn.	1320		Numerous larvae on release tree in July.	Release tree dead; several adults on tree 20 ft. away in August.
		Green River, Wn.	1600		Larvae on one of two release trees in July.	Larvae and adults on two trees up to 50 ft. from release tree that had predator population in 1958.
		Wind River, Wn.	1150		No evidence of establishment	Release tree dead; numerous larvae and adults on two trees 6 ft. and 75 ft. from the release tree.
	Neoleucopis obscura	Green River, Wn.	700		No evidence of establishment.	No evidence of establishment.

Table 10.--Summary of foreign predator releases and observations from 1957 through 1959 (Cont'd.)

Release	Released	Release area	No. released (adults)	1957 observations	1958 observations	1959 observations
1959	*Aphidecta obliterata*	Wind River, Wn.	718			Found numerous larvae and adults on release tree in June and July.
	Aphidoletes thompsoni	Black Rock, Ore.	10495			Larvae on several trees in the immediate release area in July and August.
		Coldwater Cr, Wn.	3323			A few larvae found on release tree in August.
		McKenzie Pass, Ore.	3850			A few larvae found on release tree in August.
		Monroe, Ore.	157			No evidence of establishment.
		Randle, Wn.	2062			Numerous larvae found at bottom of release cage, ready to pupate in mid-August.
		Willamette Pass, Ore.	9162			Numerous larvae on many trees in the release area from July through September.
	Cremifania nigrocellulata	Corvallis, Ore.	159			A few larvae found on release tree in July and September.
		Monroe, Ore.	830			A few larvae and one pupa on release tree in July.
	Laricobius erichsonii	Monroe, Ore.	800			Numerous larvae found on both release trees in May and June.
		Long Tom R.,	800			
	Leucopis sp.	Monroe, Ore.	15			No evidence of establishment

Table 10.--Summary of foreign predator releases and observations from 1957 through 1959 (Cont'd.)

Release	Released	Release area	No.released (adults)	1957 observations	1958 observations	1959 observations
1959	Neoleucopis obscura	Willamette Pass, Ore.	2085			Larvae found that are probably Neoleucopis, positive identification needed to distinquish from larvae of native Leucopis.
	Scymnus (Diomus) pumilio	Coldwater Cr.,Wn.	859			Prey population gone; release tree formed secondary periderm; no evidence of establishment on adjacent trees.
	Adalia tetraspilata var. bispilota	Santiam Pass, Ore.	21			Unobserved following release.
		Portland, Ore.	54			Not present three weeks following release.
		Monmouth, Ore.	14			Unobserved following release.
	Synharmonia conglobata	Santiam Pass, Ore.	30			Unobserved following release.
		Randle, Wn.	91			Unobserved following release.
	Exochomus uropygialus	Green River, Wn.	1641			Adults on bole three weeks following release.
		Corvallis, Ore.	316			Not present three weeks following release.
	Ballia eucharis	Black Rock, Ore.	85			Not present two weeks following release.
	Leis dimidiata	Willamette Pass, Ore.	15			Unobserved following release.
		Monmouth, Ore.	8			Unobserved following release.
	Harmonia breiti	Portland, Ore.	10			Not present three weeks following release.

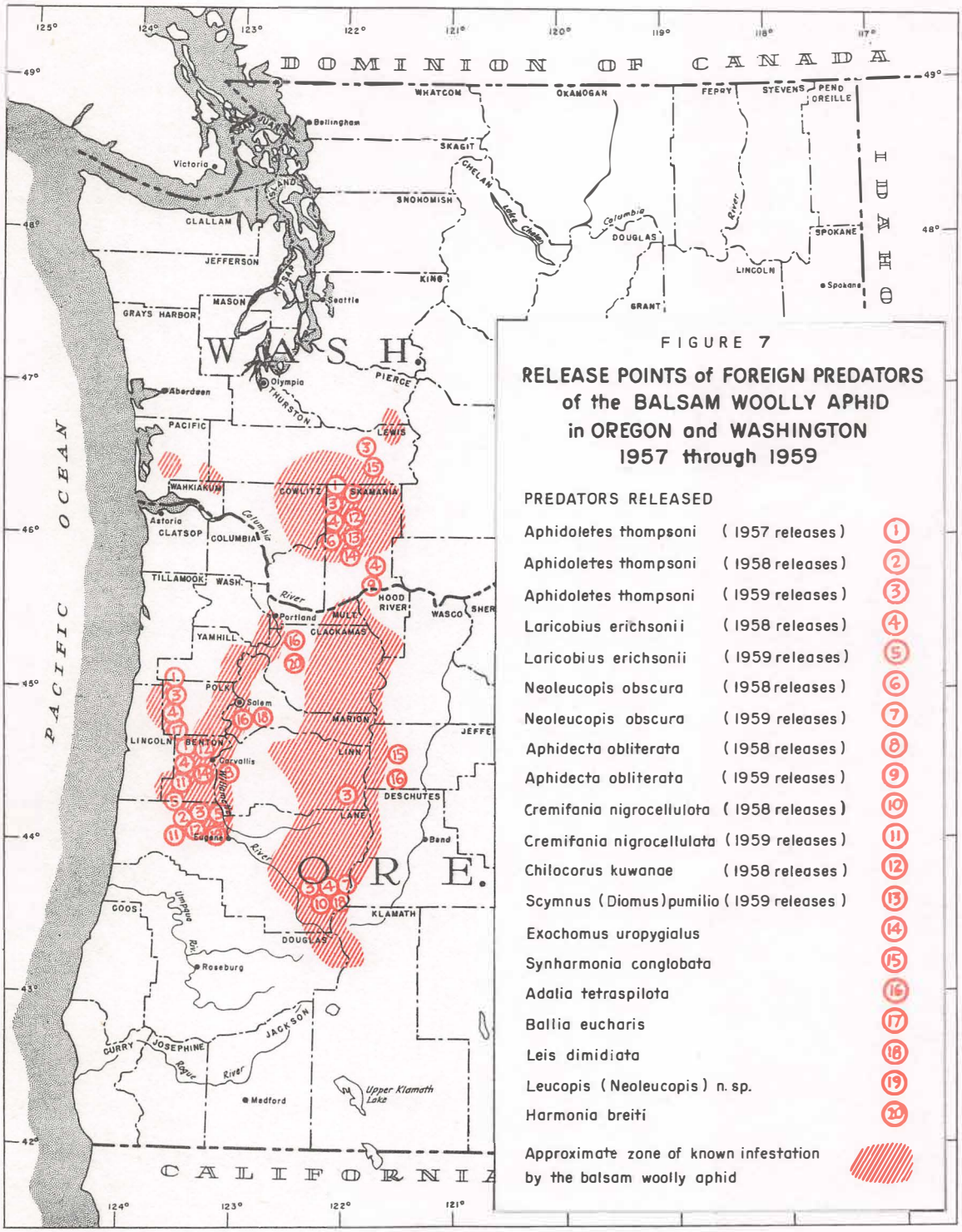

FIGURE 7

RELEASE POINTS of FOREIGN PREDATORS of the BALSAM WOOLLY APHID in OREGON and WASHINGTON 1957 through 1959

PREDATORS RELEASED

Aphidoletes thompsoni	(1957 releases)	1
Aphidoletes thompsoni	(1958 releases)	2
Aphidoletes thompsoni	(1959 releases)	3
Laricobius erichsonii	(1958 releases)	4
Laricobius erichsonii	(1959 releases)	5
Neoleucopis obscura	(1958 releases)	6
Neoleucopis obscura	(1959 releases)	7
Aphidecta obliterata	(1958 releases)	8
Aphidecta obliterata	(1959 releases)	9
Cremifania nigrocellulota	(1958 releases)	10
Cremifania nigrocellulata	(1959 releases)	11
Chilocorus kuwanae	(1958 releases)	12
Scymnus (Diomus) pumilio	(1959 releases)	13
Exochomus uropygialus		14
Synharmonia conglobata		15
Adalia tetraspilota		16
Ballia eucharis		17
Leis dimidiata		18
Leucopis (Neoleucopis) n. sp.		19
Harmonia breiti		20

Approximate zone of known infestation by the balsam woolly aphid